one may slip a key or other object into a child's hand and have it held until the hand opens and the key falls, evidently without the child's knowing it. The ease with which a child may be distracted is well known. A crying child is appeased by drawing its attention away from the source of trouble. The case is cited of a child much put out by being presented to strangers, but who at once stopped crying when a match was lit. As soon as the match went out, the crying recommenced, and so on, for several minutes. We here see an alternation of the mental view that would be regarded as abnormal in the adult. The contrast between this and the elaborate means necessary to gain mental diversion in adult life is certainly striking.

The time of mental acts can be studied in children old enough to understand what is asked of them. Ordinary observation shows that children are slow in responding to a stimulus. Actual measurements were taken by having children press upon a tube as soon as they heard a sound. The average adult time for this re-action is .14 of a second. Children from four to seven years old require over half a second to do the same thing. The times, too, are irregular, from a minimum of one-fifth of a second to a maximum of a second or more, indicating an irregularity in the power to fix the attention upon so artificial a task. When the time was measured, the curve of contraction was also written. This in the adult is a quick, sudden stroke, occupying about .34 of a second. In three of the children the movement occupied over half again as much time, and in one child was as long as two seconds. This suggested a test of the maximum number of pressures a child and an adult could make in a given time. The adult makes 18 (in an extreme case 27) in 4 seconds, while the children averaged only 9 pressures in the same time. We have thus indicated in a variety of ways the gradual development of human faculty, as well as the unconscious education we pass through in childhood, and the means of educationally utilizing it.

The Sensations of Movement

We are getting to appreciate more and more how much of mental life is founded upon the information obtained through the contraction of muscles. The exact determination of how this knowledge is obtained becomes correspondingly important. A recent study by M. Bloch sheds interesting light on some phases of this question (*Revue Scientifique*, March 8, 1890). It is to be observed at the outset that we have no direct knowledge of the muscular changes produced in the muscles themselves when they contract. When we close the hand, all the sensation is in the hand itself, while the muscles whose contraction brings on the movement are farther up in the fore-arm. It is, then, from the sensations of compression of the skin and the movement of joints that we obtain our notions of movement. There are indeed certain secondary associative contractions of muscles, coming a slight fraction of a second after the contraction of the muscle we innervate, that seem to tell us of the realization of the intended contraction. While thus ignorant of the means of muscular contraction, we can direct its extent and direction. We can set the vocal chords to sing a certain note, but in many cases these adjustments are simply a series of tentative attempts, and even then liable to some considerable errors. For the motions of the arms this was tested in the following way. The two leaves of a screen standing at about an angle of eighty degrees to each other had their sides covered with ruled paper, and the general problem was for the observer in a definite position in front of the screen to find with the two arms corresponding places upon the two leaves of the screen. The movements of the two hands were most nearly alike when the movements were nearest to the body and near the line of the eyes, although the eyes in these experiments were of course closed. The difference in position of the two hands is about 1 centimetre in this region; this when the two hands are moved together. If the one hand is placed, and the other is to find a corresponding position, then the task is much more uncertain, and the error larger; the error being 5 centimetres, where it was but 1 centimetre before. If this process depends upon the contraction of muscles, then the error should be larger if the one arm is moved passively by an assistant, while the other arm finds the position in which the first was placed. An actual test showed that under such conditions the process is quite as exact as before. This independence between the perception of the position of our limbs and the muscular contraction was further shown by placing the wrist of one hand through a ring suspended by a rubber band from the top of the screen. To find a place low down on the screen, the hand must pull against the rubber band, and this should make all the adjustments too high; but no such effect occurs. Again, if a weight of 2 kilograms be attached to either wrist, it does not change the accuracy of the adjustments. Another kind of muscular sensation was tested by taking a number of leaves of a book in between the thumb and forefinger of one hand, and finding with the other an equal number of leaves. This error for a small number of leaves was about one fifteenth the number of leaves, but for a larger number this ratio decreased. It makes some difference whether the right or the left hand is the judging hand; and for M. Bloch, who is left-handed, the left hand feels lengths as larger than equal lengths in the right hand.

We also have no definite knowledge of the precise time of a muscular contraction. If we attempt to beat time with a metronome by the rhythmical contraction of a muscle, we imagine that we begin the motion as the metronome beats; but in fact it is the end of the movement that coincides with the beat of the metronome, the real contraction preceding it by a considerable fraction of a second. More curiously still, if an impulse is sent out at the same time to a muscle near the brain (say, the muscles moving the jaws) and to muscles far away (say, those moving the foot), the impulse will reach the foot later. If, now, we keep time with a metronome by alternately contracting the jaw and the foot, then we really begin the movement of the foot earlier than that of the jaw, so that the close of the movements shall coincide with the sound.

The intensity of muscular sensations, M. Bloch subjected to only a very rough test. After many unsatisfactory modes of testing, he used a form of balance, on the short arm of which was suspended a constant weight, and along the long arm of which the finger moved, keeping the beam horizontal. The finger was placed in a certain position, and then moved as little one way or the other as was necessary to tell that the pressure had changed. From this the ratio of pressures at the two positions was calculated, and found to be about 1: 4.3. In this both the muscle sense and the pressure-sense are used. To rule out the former, a brace was placed above the beam, so that the weight pressed against the finger, but the latter need not support it. The ratio thus determined was 1:3. The pressure-sense was eliminated by wrapping thread around the finger, and then the sensibility was determined to be 1: 2.5, so that both these senses contribute to the common result.

BOOK-REVIEWS.

A Primer of Phonetics. By HENRY SWEET, M.A. New York, Macmillan. 16°. 90 cents.

THIS work makes use of "Visible Speech" to teach the elements of phonetics, and to denote the analysis of English, French, and German sounds. All the details of "Visible Speech"—its organic and phonetic classifications, its terminology, and even its symbolic notation—are borrowed in wholesale, in a way that, however flattering to the author of the system, cannot be satisfactory to its students: for Mr. Sweet has made "a few modifications" of the symbols; and, notwithstanding that these have been repudiated by the author of "Visible Speech" as not in harmony with the fundamental principles of his system, they are here incorporated with it, without any indications to distinguish the innovations from the original parts of the scheme. The "Visible Speech" notations should at least have been shown in comparison with the substitutions, so that a student might use the one or the other, as his preference might dictate. Without the symbols themselves, the objectionable character of the "modifications" cannot be made clear; but the ground of the objections will be understood from the statement that the mutual relations of the

sounds of *p b m, t d n, k g ng*,—depicted in the "Visible Speech" symbols,—are entirely *in*visible in the substituted symbols for the sounds of *m n ng*. So, also, for the symbols of *s sh th*, —which form a related series in "Visible Speech,"—the "modifications" depart altogether from the original plan of symbolization by substituting a set of merely arbitrary forms.

In some few points Mr. Sweet disputes the correctness of the "Visible Speech" analysis; for example, in the sound of *ah*, the "low back wide" vowel which Mr. Sweet says should be the "mid back wide." Such difference of opinion is of course legitimate, but each opinion should be attributed to its proper author. In the preface to this book Mr. Sweet says, "I feel convinced that the path of progress lies through the 'Visble Speech' analysis, and that the first duty of the very few who have a practical command of it is to do what they can to spread the knowledge of it." Yet in the above case Mr. Sweet gives his own analysis only, and makes no reference to its divergence from that originally made, and still upheld, by the author of "Visible Speech." The same procedure is further manifested in the introduction of symbols for the teeth, turned in different directions – as, surely, never teeth were turned – to represent the sounds of *th* and *f*. In reference to these symbols, Mr. Bell says, in his "Lectures on Phonetics," "The symmetry of the system has been deformed in republications which have been made without leave asked or given. One emendator, it seems, had supposed the system wanting in symbols for the teeth, and accordingly he actually provided it with a set. 'Visible Speech' was certainly not born with teeth; or, rather, teeth being in the mouth, their presence is implied as a matter of course, and requires no symbolizing – as they are not in the habit of shifting their root-fast positions. The teeth, like the hard palate, are only passively employed; and it will be time enough to call in dental aid when the teeth are shown to be the active agents in forming any oral sound."

In spite of this protest, Mr. Sweet brings in his symbols for the teeth, without a word to show that they form no part of the original system. This is altogether indefensible. "Visible Speech," as we learn from the inaugural volume, cost its author the labor of twenty years: and, although its inventor might be scientifically glad to see his system superseded by a better, no person can look with equanimity on wanton interference with so elaborate a plan. All that Mr. Sweet has to say in his "Primer" might have been said —if not better said—within the limits of the symbolism that has not, we are told, been found wanting in means to discriminate the phonetics of any language. Mr. Sweet's "modifications" cannot be accepted as legitimate; far less can they be considered as improvements: but the chief objection to them is that they are mixed up with the true "Visible Speech," as if they formed part of the system. In it, yet not of it, they misrepresent it, and mislead the learner.

Simple Elements of Navigation. By LUCIEN YOUNG. New York, Wiley. 16°.

To the yachtsman who annually, and about this time of year, goes down to the sea in a schooner, or a sloop, or a cutter, or perchance in a steam or naphtha launch, this little pocket-volume will prove invaluable; and to the naval apprentice, the petty officer, or the ambitious able seaman, it will be of greater immediate assistance on the road to promotion than more pretentious works intended for the use of accomplished mathematicians and experienced navigators. The treatise is not intended to take the place of any other work, for we know of no other of similar scope; nor does it aim to supply any real or imaginary deficiency in previous works on the subject. It is put forth as a compendium or epitome of the simple elements of navigation, containing every thing necessary to enable a man of ordinary intelligence, with a little "seafaring education," to navigate a vessel to any port in the world; but it does not aim to supplant more comprehensive works on navigation. All complicated mathematical formulas are omitted, and also all calculations not readily and easily comprehended and performed. About one-half the volume is of necessity given to the tables of difference of latitude and departure; refraction, dip, and parallax; declination of the sun; equation of time; sines, tangents, and secants; etc.; without which no work of the kind is complete.

But, good as the book is, it has serious defects, which we hope to see remedied in later editions. These defects, however, while marring the literary value of the work, do not interfere with its value for the main purpose the author had in view. They arise from the attempt to condense into a few pages matter which, from its nature, does not readily lend itself to condensation. As a consequence, there are many sentences in the book which must be carefully studied, read over and over again, before the meaning is apparent. To the author, of course, familiar with the subject, all is clear; but to the student, to whom navigation may be "all Greek," the translation into plain English of puzzling obscurities, produced by ultra-condensation, may be a distasteful task. Then there are occasional lapses in grammar and in diction, which would not be so noticeable were they not in so noticeable a work. As a whole, the treatise is a good one, the need of such a work was felt, and we have no doubt that it will have a cordial reception.

A Century of Electricity. By T. C. MENDENHALL. Boston and New York, Houghton, Mifflin, & Co., 1890. 12°. $1.25.

THIS is a second edition, with additions, of this book, which was first published in 1886,—with additions, we note, as the progress of electrical science, which has been made mostly in the last hundred years, did not cease four years ago, but has made further strides Many of these advances have been in the applications of electricity to the production of light, and, in a broad way, to the transmission of power. Four years ago electrical appliances were popping up on every side, each putting forth a claim to great usefulness and to perfection. This activity in a new industrial field gave rise to the inevitable fever of speculation, which could but result in great disappointments, as the incompleteness of the novel inventions as they then stood was shown by experience. Then, again, the use of so powerful an agent in methods most crude led to disasters to human life and property, that aroused hostility to the new force. Our author traces all this matter of history, and shows how even the much talked of alternating currents have been gradually made more amenable to human wants, and records the general settling-down to really useful work of the electrical industries.

But it is on the side of theory also that enormous advances have been made recently in electrical science. Many know that a connection between electricity and light was suspected a dozen or twenty years ago by Clerk Maxwell. Now, in his additions, Professor Mendenhall records the experiments of Hertz, which show the suspicion of twenty years back to be true.

Many are interested in the display of electrical energy on every hand, and yet know little of how it has come to pass that there are electric cars, electric lights, electric printing-presses. For these Mendenhall's "Century of Electricity" is intended, and that they may rely upon it is shown by the fact that in two years only two errors have been pointed out in the text; and one of these dates back to Faraday himself, who overlooked a misstatement of one of the laws he discovered in his own publication of them,—an error which was inadvertently copied.

The Elements of Laboratory Work: A Course of Natural Science. By A. G. EARL. London and New York, Longmans. 12°.

THE author is a late scholar of Christ's College, Oxford, and now science master at Tonbridge School. The book is for use in laboratory work, and presupposes a fairly well stocked room for the instruction of beginners in physical science. The field of work is somewhat more limited than is frequently the case with books of this class, experiments on the physical and to some extent on the chemical properties of matter being made most prominent. Electrical measurements, which lend themselves admirably to higher laboratory work in physics, are but sparingly referred to. For ourselves, we do not approve of the minuteness with which the primary facts in regard to matter are supposed to be observed by the student using Earl's methods, but we are